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Proximate and Sensory Analysis of Organic Fish Feed from Fermented Coconut Meal and Earthworm Meal

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Abstract

Background: Fish cultivation is increasingly developing in Indonesia with increasing market demand. The main factor influencing the success of fish farming is the quality of the feed given to the fish. However, it should be noted that some commercial fish feeds contain chemicals that can harm fish health. One option to overcome this problem is to develop organic fish food from fermented coconut dregs and earthworms. **Methods:** Proximate tests were carried out with three formula designs, namely formulas A1, A2, and A3, with a ratio of fermented coconut dregs flour and earthworm flour, respectively 1:2, 2:1, and 1:1. Feed sensory tests were also carried out, which included color, aroma, and texture of organic fish feed. The proximate test was carried out at the Surakarta Goods Quality Testing and Certification Center, while the sensory test was carried out by giving feed samples to 20 panelists. The data collected was then analyzed using IBM SPSS Statistics version 23. **Results:** Proximate test results were the average protein content of fish feed formulas A1, A2, and A3 respectively 10.85%, 16.28%, and 13.07%, while the average carbohydrate content of formula fish feeds A1, A2, and A3 respectively 30.04%, 26.54%, and 27.91%. Meanwhile, the sensory test results for the color of formula feed A1, A2, and A3 had scores of 1.70, respectively, 3.70, and 2.45. The results of the sensory test for the aroma of formula feed A1, A2, and A3 had scores of 2.90 respectively, 3.45 and 3.05, while the results of the sensory test for the texture of formula feed A1, A2, and A3 had scores of 2.20 respectively; 3.40; and 3.30. **Conclusions:** The most effective feed formula given to fish is formula A2, which has the highest protein content, reaching 16.28%, and carbohydrate content, 26.54%.

Keywords: Fish feed; Coconut dregs; Earthworms; proximate; Sensory

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Introduction

Many Indonesians are developing fish farming because of the high market demand, easy maintenance, and the relatively fast harvest period. The main factor influencing fish farming is providing food that suits the fish's needs. However, the problem currently being experienced by fish farmers is the high feed price, so their profits are decreasing (Muntafiah, 2020). In addition, some commercial fish feeds contain dangerous chemicals such as pesticides, herbicides, heavy metals, artificial chemicals, antibiotics, and artificial pigments. Therefore, there is a need for alternative fish feed made from organic materials with high nutritional content to accelerate the growth and development of fish.

Organic fish food generally uses a combination of ingredients so that its nutritional content is optimal for fish growth. The feed ingredients used can be a combination of vegetable ingredients, animal ingredients, or a mixture of both. Research (Hermanto & Fitriani, 2019) created organic fish feed from cassava skin and leaves. The results showed that treatment 2, with a ratio of 3:1 cassava skin and leaves, had the highest nutritional content, namely 18.15% crude protein and 3.73% fat. Meanwhile, in research (Sajuri, 2019), which used a combination of maggot flour and Azolla, the best results were at grade 1, which contained 33.70% protein, 26.28% fat, and 17.32% carbohydrates. Besides using organic materials, fish food can be made from other organic materials such as corn, coconut cake, tofu dregs, and coconut dregs.

Coconut dregs are waste from making coconut milk, where coconut dregs consist of crude fiber and remaining coconut meat, which still contains a small amount of coconut oil. Coconut dregs are usually left alone, which can cause environmental problems such as water pollution, soil pollution, and waste management problems. Therefore, ecological issues, coconut dregs can be processed into raw materials for organic fish feed because its nutritional content is relatively high in the form of 6.99% water, 5.78% protein, 38.23% fat, 33.64% carbohydrates, 0.26% ash, and 15.06% crude fiber (Yespus et al., 2018).

They must go through a flouring process to make it easier to process coconut dregs into organic fish food. However, previously, the coconut dregs required to be fermented to reduce the crude fiber content, potentially hindering the fish's digestibility. The fermentation process can be done by adding tapai yeast at 2 grams to 1 kilogram of coconut dregs (Merdekawati et al., 2023). After fermentation, the crude fiber content of coconut dregs decreased from 29.29% to 22.34% (Fadhilah et al., 2022). Next, the fermented coconut dregs are ground into flour containing 3.42% water, 0.42% ash, 5.14% protein, 7.40% fat, 2.49% fiber, and 83.62% carbohydrates (Rousmaliana, 2019). The high carbohydrate content in coconut dregs can be used as an energy source to replace protein and increase fish digestibility (Putri et al., 2021).

Coconut dregs flour contains low protein, so additional ingredients are needed to increase the protein content in organic fish feed. High protein levels can be obtained from animal materials such as earthworms. Earthworms contain 76% protein, 17 % carbohydrates, 4.5% fat, and 1.5% ash (Astino et al., 2021). The high protein content in earthworms can accelerate fish growth. Apart from their high nutritional content, earthworms contain the compound lubricant, which acts as an antimicrobial that can increase fish immunity (Yushra et al., 2022).

Even though there are many commercial fish feeds, several feed brands contain chemicals, so alternative organic fish feed is needed, as studied in research (Hermanto & Fitriani, 2019), which chose a combination of cassava skin and cassava leaves. This research showed that the feed contained 18.15% crude protein and 3.73% fat. However, this research did not consider the carbohydrate content in feed, which fish need as a source of energy to replace protein and increase fish digestibility. Therefore, this research was carried out to determine protein and carbohydrate levels and sensory feed, including color, aroma, and texture of organic fish feed from fermented coconut dregs flour and earthworm flour.

Method

Time and Place

This research was conducted from December 2023 to February 2024 at the Biology Education Laboratory, Faculty of Teacher Training and Education, Muhammadiyah University, Surakarta, while the proximate analysis was carried out at the Surakarta Goods Quality Testing and Certification Center. Next, sensory analysis was carried out on 20 panelists at the Depok Surakarta Ornamental Fish Market and the banks of the Bengawan Solo River.

Tools and materials

The tools used in this research consisted of buckets, basins, spoons, sieves, filter cloths, ovens, stoves, steaming pans, scales, grinders, measuring cups, pH meters, jars, labels, stationery, cameras, and storage space. Meanwhile, the materials needed for this research are earthworms, coconut dregs, bran, tapioca flour, tapai yeast, distilled water, and 70% alcohol.

Research Design

There are three organic fish feed formulas using fermented coconut dregs flour and earthworm flour, which are shown in Table 1.

Table 1. Organic fish feed formula from fermented coconut dregs flour and earthworm flour

Material Raw	**Formula (gram)**		
	A1	**A2**	**A3**
Fermented coconut dregs flour	70	35	52,5
Earthworm flour	35	75	52,5
Bran	10	10	10
Tapioca flour	20	20	20
TOTAL	135	135	135

Fermentation of Coconut Dregs

The first step is to choose good quality coconut dregs that are white and odorless, then weigh 1 kilogram of coconut dregs using a digital scale. Next, steam the coconut dregs for 45 minutes, then let it sit until it cools (Merdekawati et al., 2023). After that, add tapai yeast in a ratio of 1:0.002, where for every 1 kilogram of coconut dregs, add 2 grams of tapai yeast. Then, stir the coconut dregs and tapai yeast until homogeneous, then put it in a jar. Next, close the jar using a plastic perforated with a needle. Then, incubate for two days at room temperature and check the pH of the coconut dregs at the time of harvest.

Making Coconut Dreg Flour

Dry the fermented coconut dregs using an oven at 60ºC or dry them in the sun for 3-5 days (Merdekawati et al., 2023). Then, grind the fermented coconut dregs using a grinder until they become flour. Then, sift the fermented coconut dregs flour with a 40 mesh size to make the flour more homogeneous.

Making Earthworm Flour

Wash earthworms with running water to remove contaminants on the outer skin of the worms (Astino et al., 2021). Then, dry the earthworms using an oven at 50°C for 24 hours and grind them using a grinder until they become flour (Astino et al., 2021). Next, sift the earthworm flour with a 40 mesh size so that the size of the flour is more homogeneous.

Manufacture of Organic Fish Feed

The first step in making organic fish food is to prepare a feed formulation adapted to the needs of herbivorous fish, then weigh the feed raw materials in the form of fermented coconut dregs flour and earthworm meal using a digital scale according to the predetermined ratio. Then, weigh the feed additives as bran and tapioca flour using a digital scale, 10 grams and 20 grams, respectively (Setyaningrum & Suryani, 2017). Next, put all the ingredients weighed into the basin, stir until evenly mixed, and add water gradually to bind the dough (Saputro et al., 2021). After that, print the feed mixture using a printer, then dry the organic fish food in the oven or the sun for 3-5 days until it is dry and does not feel sticky to your hands (Setyaningrum & Suryani, 2017). The final step is to store organic fish food in a closed container that has been labeled and then place it in a dry place (Amin et al., 2020).

Proximate Test of Organic Fish Feed

A proximate protein and carbohydrate content test was carried out by weighing 100 grams of A1, A2, and A3 feed formulas and then labeling the plastic packaging; then, the samples would be tested proximately at the Surakarta Goods Quality Testing and Certification Center.

Sensory Test of Organic Fish Food

The feed sensory test was carried out using the panelists' hedonic quality test (liking test) method for each formula's color, aroma, and texture. The senses involved in the feed sensory test are sight, smell, touch, and hearing. Sensory tests were conducted on 20 panelists, including lay people, anglers, fish farmers, and ornamental fish sellers, with a score range of 1-4, where 1 = dislike, 2 = don't like, 3 = like, 4 = really like. Then, the sensory test data were analyzed using IBM SPSS Statistics version 23 with ANOVA analysis of variance to identify samples with the highest average values, which were then explained using descriptive statistics. Differences between means were tested using the Duncan Multiple Range Test (DMRT) with a significance level of ($p < 0.05$).

Result

The following is a picture of organic fish food from fermented coconut dregs flour and earthworm flour.

Formula A1 Formula A2 Formula A3

Figure 1. Organic fish feed from fermented coconut dregs flour and earthworm flour in each formula

Analysis was carried out using IBM SPSS Statistics version 23 with ANOVA analysis of variance to determine which formula had the best protein and carbohydrate content. The results of the ANOVA analysis can be seen in Table 2.

Table 2. ANOVA test results for protein and carbohydrate content

Formula	Proximate Organic Fish Feed	
	Protein	Carbohydrate
A1	10.85 ± 2.14^{a}	30.04 ± 2.31^{a}
A2	16.28 ± 1.65^{b}	26.54 ± 0.83^{a}
A3	13.07 ± 0.49^{a}	27.91 ± 0.69^{a}

Note: Numbers followed by the same letter in one column indicate no significant difference based on the 5% DMRT test.

After obtaining the results of the proximate protein and carbohydrate tests for organic fish feed, a sensory test was carried out, including the color, aroma, and texture of organic fish feed, on 20 panelists. The following are the assessment criteria for the sensory hedonic quality test of organic fish feed from fermented coconut dregs flour and earthworm flour.

Table 3. Evaluation criteria for sensory hedonic quality tests

Sensory Parameters of Organic Fish Feed	Scoring			
	1	2	3	4
Color	Very pale	Pale	Dark	Very Dark
Aroma	Not very fishy	Somewhat fishy	Fishy	Very fishy
Texture	Very rough	Somewhat rough	Smooth	Very smooth

Table 4. Sensory ANOVA test results for color, aroma, and texture

Formula	Color	Aroma	Texture
A1	1.70 ± 0.470^{a}	2.90 ± 0.718^{a}	2.20 ± 0.410^{a}
A2	3.70 ± 0.470^{b}	3.45 ± 0.510^{b}	3.40 ± 0.681^{b}
A3	2.45 ± 0.510^{c}	3.05 ± 0.686^{a}	3.30 ± 0.470^{b}

Note: Numbers followed by the same letter in one column indicate no significant difference based on the 5% DMRT test.

Table 5. Comparison of physical characteristics of commercial fish feed and organic fish feed

Parameter	**Formula**			
	Commercial Feed	**A1**	**A2**	**A3**
Color	Very dark (dark brown)	Pale (gray-brown)	Very dark (dark brown)	Dark (light brown)
Aroma	Very fishy	Very fishy	Very fishy	Slightly
Texture	Very dense and smooth Brittle	Rough, very fibrous, Very dense,	Rough and slightly fibrous	Dense, rough, and fibrous

Discussion

Based on the results of proximate analysis of the protein content in the organic fish feed from fermented coconut pulp flour and earthworm meal, it was found that formula A2 had the highest protein content with an average of 16.28%. In comparison, formula A1 had the lowest protein content, with an average of 10.85%. Likewise, with the results of the ANOVA analysis, there is a significant difference between formula A2 and formulas A1 and A3, where the test value for formula A2 is the highest. The composition of the feed raw materials influences the high protein content in the A2 formula. Formula A2 uses earthworm flour in large quantities, thereby increasing the feed's protein content. In line with research (Razid et al., 2021), earthworm flour has a protein content of 60.40% and contains all the essential amino acids. The amino acid content in feed raw materials also influences the protein content in feed. Feed needs essential amino acids because the fish's body cannot synthesize them directly (Ahmad et al., 2021). Apart from that, the addition of fermented coconut dregs flour and rice bran can also increase the protein content of feed because both contain protein of 3.57%-5.79% respectively (Kasio et al., 2021) and 9.163% (Mila & Sudarma, 2021). However, the protein content in organic fish feed has decreased compared to the protein content in raw materials due to protein denaturation during the feed oven process. However, the protein content in A2 formula feed is still higher than that of commercial fish feed, which is only 12%. The protein content of formula A2 can meet the nutritional needs of herbivorous fish by 15-30% (Manik, 2021). Fish really need the protein content in fish to support growth and development (Islama et al., 2020), carry out metabolism, repair damaged body cells (Silaban et al., 2021), and maintain the function of more vital body tissues (Sulistiyoningsih et al., 2021).

Next, a proximate analysis was conducted on the carbohydrate content in organic fish feed from fermented coconut pulp flour and earthworm meal. The proximate analysis showed that formula A1 had the highest carbohydrate content, reaching an average of 30.04%, while formula A2 had the lowest carbohydrate content, with an average of 26.54%. Likewise, the results of the ANOVA analysis show that formula A1 has the highest test value and formula A2 has the lowest test value. This proves that adding coconut dregs to the feed formula can increase the carbohydrate content of the feed. Coconut dregs flour contains 23.77% carbohydrates (Netcha et al., 2021). Another factor contributing to the high carbohydrate content in A1 formula feed is the addition of other raw materials, such as earthworm meal and rice bran. Previous studies show that earthworms have a carbohydrate content of around 17% (Organic Universe Team, 2020), while rice bran contains 49.69% carbohydrates (Sapwarobol et al., 2021). The carbohydrate content in the three feed formulas ranges from 26.54% - 30.04%, exceeding the carbohydrate content in commercial fish feed, which is only around 22.5%, so the three feed formulas are by the standard fish carbohydrate requirements. This is in line with Abro (2014), who states that omnivorous fish require around 20-40% carbohydrates, while carnivorous fish require around 10-20% carbohydrates. The high carbohydrate content in feed functions as an energy source, increases fish digestibility (Putri et al., 2021), and acts as a sparing effect of protein (Li et al., 2020). Apart from that, if there are excess carbohydrates in the fish's body, these carbohydrates will be stored as glycogen. This glycogen can be energy reserves and synthesize non-essential amino acids and fats (Alristina, 2021).

Next, a sensory test of the color of organic fish food was carried out, based on Figure 3. It can be seen that the A2 formula has the highest score of 3.7, while the A1 formula shows the lowest score, namely 1.7. The three feed formulas also show significant differences, as shown in Table 8. Different letters in the color sensory column follow the test result numbers. The results of this sensory test indicated that in terms of color, the panelists preferred the A2 formula because the color was similar to the color of commercial fish food, namely dark brown.

On the other hand, the A1 formula has a pale color (gray-brown), so it looks less attractive. The color differences between feed formulas are influenced by the composition of the raw materials that make up the feed (Rosellia et al., 2023). The use of earthworm meal in feed formulas tends to make the color of the feed darker. Apart from that, the feed oven process also influences the color of the feed to become darker. Even though the color of the feed does not affect the fish's interest in consuming it, the feed's color influences consumers' attractiveness to buy it (Ashuri et al., 2021).

Then, we continued with the feed aroma sensory test, and the results obtained were as shown in Figure 3. Formula A2 had the highest test score, 3.45, while Formula A3 had the lowest, 3.05. Meanwhile, according to Table 8, formulas A1 and A3 do not show a significant difference, indicated by the test result number followed by the same letter. On the other hand, formula A2 shows a substantial difference from formulas A1 and A3, expressed by the test result number followed by a different letter. From the results of the ANOVA analysis, it can be stated that the feed aroma with the highest preference from the panelists is the aroma of formula A2 feed because it is very fishy, like fish feed on the market. The food's very fishy smell can attract the fish's attention so that the fish will consume the food more quickly. The fishy smell in feed comes from the composition of the feed (Ashuri et al., 2021), where the more animal protein used in the feed, the more fishy the feed will smell. This is because animal protein contains a compound called an attractant, which can stimulate the attractiveness of fish (Yu et al., 2021), increasing feed consumption, growth, and fish interest in food. The smell of food has a crucial role in attracting fish's attention to food. The nutritional content of the feed will be less efficient if the feed does not contain a composition that can attract fish.

The final sensory test is the feed texture test, where the test results are shown in Figure 3. Formula A2 has the highest score of 3.40, while Formula A1 has the lowest score, 2.20. Meanwhile, according to Table 8, formulas A2 and A3 show no significant difference because the test results follow the same letter. In contrast, formula A1 significantly differs from formulas A2 and A3 because the test results are followed by different letters. Based on the ANOVA analysis results, the panelists preferred the A2 formula because it has a very dense, rough, and fibrous texture. Hence, the feed is not susceptible to being destroyed when spread in water. The dense feed texture in the A2 formula is influenced by adding tapioca flour to increase the feed's adhesive power (Arifin et al., 2023). Adding suitable tapioca flour can increase the bond strength between feed particles.

Meanwhile, the rough and fibrous texture is influenced by using feed raw materials in fermented coconut pulp flour. The texture of this organic fish food is slightly different from that of commercial fish food on the market. Usually, the commercial feed has a dense and smooth texture because the manufacturing process is assisted by an extruder machine (Micheal et al., 2021), while the manufacturing process for this organic fish feed is still traditional. Hence, the feed still has a slightly rough texture (Safitri et al., 2020).

Conclusions

Formula A2 is ideal for herbivorous fish because it contains the highest protein, reaching 16.28%, and carbohydrates at 26.54%. Formula A2 also received the highest preference from panelists regarding color, aroma, and texture.

Declaration statement

The authors reported no potential conflict of interest.

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